Current Review of DOE’s Syngas Technology Development

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Why the Interest in Syngas from Coal?

- **Abundance of coal in U.S**

  - [Diagram showing U.S. Coal Resources in billion short tons]

  - [Link: https://www.eia.gov/energyexplained/index.cfm?page=coal_reserves]

- **A variety of products!**

- **Most of the world has no cheap natural gas**
Gasification: More than just Electricity

Gasification can be

- Used to make: hydrogen, fertilizer, chemicals (methanol, plastics, etc.) and transportation fuels
- Lowest cost option to make power with almost total carbon dioxide (CO₂) capture and storage

Syngas production through gasification, syngas cleanup, and syngas conversion technologies are the core of process systems for making value-added products
Varied Product Slate from Syngas

Source: NETL
Technology Advancement Areas in Gasification, Supported by DOE Projects

Advances in gasification technology, quantified in terms of reductions of capital costs and COE, also reduce the cost of transportation fuel production.
DOE Gasification Key Technology Areas

Increasing efficiency and improving economics of syngas production and processing

Feed Systems
- Efficient, lower-cost oxygen separation
- Expand fuel flexibility (coal/biomass/MSW) through high-pressure solid feed technology advancements

Gasifier Optimization and Plant Supporting Systems
- Improve reliability & availability of gasifiers
- Improve gasifiers for low-rank coals & opportunity feedstocks
- Improve materials, sensors & controls, fouling/slagging abatement

Syngas Processing Systems
- Efficient control of multiple contaminants to extremely low levels to both regulatory demanded limits and removing potential contaminant effects of syngas-utilizing processes
- Hydrogen-rich syngas from raw syngas
Innovative Technology for Syngas Production: DOE Projects

Syngas Production from Catalytic Coal Gasification—
Improving high hydrogen syngas production and limiting methane by-production at moderate process conditions

- Catalytic PRB Coal-CO₂ Gasification for Fuels and Chemicals with Two Different Types of Syngas and Low CO₂ Emissions – U of Wyoming
- Application of Chemical Looping with Spouting Fluidized Bed for Hydrogen-Rich Syngas Production from Catalytic Coal Gasification - U of Kentucky
- Advancing Coal Catalytic Gasification to Promote Optimum Syngas Production – V. Tech

Source: U of Kentucky
Innovative Technology for Syngas Production: DOE Projects

**Chemical Looping Gasification**—

\( \text{CO}_2 \) is intrinsically isolated from syngas facilitating high-hydrogen syngas production and carbon capture

- Alstom’s Limestone Chemical Looping Gasification Process for High Hydrogen Syngas Generation - Alstom
- Pilot Scale Operation and Testing of Syngas Chemical Looping for Hydrogen Production - OSU
- Chemical Looping Coal Gasification Sub-Pilot Unit Demonstration and Economic Assessment for IGCC Applications - OSU

http://www.netl.doe.gov/research/coal/energy-systems/gasification/project-information/proj?k=FE0023497&show=ppp
Coal and Coal-Biomass to Liquids: Connection to Syngas

- Cost-competitive U.S. production of ultra-clean liquid transportation fuels (gasoline, diesel/jet fuel) underpinned by efficient syngas production
  - At or below lifecycle greenhouse gas (GHG) emissions from conventional petroleum
- Opportunity to combine fossil technologies with renewable or other low carbon footprint technologies to reduce overall carbon emissions impact
- Novel hydrogen production technologies

Source: NETL
C&CBTL: Key Technology Areas

**Coal-Biomass Feed and Gasification**
- Handling and processing of coal-biomass
- Biomass ash catalytic properties in gasification for improved syngas production

**Advanced Fuels Synthesis**
- Catalyst/reactor optimization for producing liquid hydrocarbon fuels and valuable by-products from coal/coal-biomass mixtures
- Improving fuel synthesis product distributions in Fischer-Tropsch conversion of syngas

Key Technologies:
- Coal-Biomass Feed and Gasification
- Advanced Fuels Synthesis
Syngas-Related Projects Managed by DOE, Funded by DOD

• Produce jet fuel from coal that is cost competitive and produces less greenhouse gas emissions than petroleum-based jet fuel production.

• Leverage DOE-FE CTL R&D while supporting the national defense mission

Source: US Air Force
Breakthrough Hybrid CTL Process Integrating Advanced Technologies for Coal Gasification, NG Partial Oxidation, Warm Syngas Cleanup and Syngas-to-Jet Fuel

RTI Technologies

- GTI AR compact gasification system
- GTI partial oxidation unit
- RTI Warm Syngas Cleanup
- RTI Syngas-to-Liquid System
- Axens Hydroprocessing Technology

Achievement

- The hybrid integrated process technology reduces capital costs by up to 34%
- Cost competitive with petroleum-based JP-8 production at oil prices above $70/bbl

Source: GTI
Indirect Liquefaction of Coal-Biomass Mixture for Production of Jet Fuel with High Productivity and Selectivity
Southern Research Institute

Technologies
• TRIG™ gasifier (test at NCCC)
• Autothermal reforming (PCI)
• Chevron hybrid F-T catalyst
• Efficient Heat Removal Incorporated
  Fixed-Bed Reactor (IntraMicron)

Achievement
• ATR catalyt testing at NCCC-demonstrated
  ability to adjust H2:CO ratio by H2O flow
  (WGS no needed)
• FT synthesis – 75% selectivity to liquid HC,
  86% jet fuel yield
Technology for GHG Emission Reduction and Cost Competitiveness of Mil-Spec Jet Fuel Production Using CTL

Ceramatec

Technology
• EERC - Transport Reactor (gasifier)
• IntraMicron - gas cleanup/desulfurization
• Ceramatec - multi-tube fixed bed F-T reactor
• Chevron – FT catalyst

Achievement
• Demonstrated > 30% reduction in GHG.
• Demonstrated 2BPD pilot
• Coal/biomass testing at EERC-UND: December 2017

Source: Ceramatec
DOE Seeks to:

- Advance syngas production, cleaning, and processing technology to reduce energy conversion capital costs and new technology costs
- Enable faster development, lower capital investment and lower financial risk open new markets for coal utilization
- Use coal to create high value products
- Lower carbon footprint of coal-based syngas production and conversion systems
- Use opportunity fuels; co-feeding coal with biomass and other carbon materials
For More Information

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Office of Fossil Energy
energy.gov/fe/office-fossil-energy

NETL
www.netl.doe.gov/research/coal/energy-systems/gasification
Thank you

Questions?